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# BAADE-WESSELINK DISTANCES TO M5 AND M92

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ABSTRACT A Baade-Wesselink analysis has been performed using new optical and infrared photometry of four RR Lyrae variables in the globular cluster M5 and two in M92. We obtain a distance to M5 of 6.9 ± 0.45 kpc and to M92 of 7.85 ± 0.45 kpc, with a 0.3 kpc additional systematic uncertainty. These results are in excellent agreement with the previously published distances, based on matching the globular cluster main sequence to that defined by the field subdwarfs of known distance.

Visual photometry at $V$ and $i$ has been obtained for five RR Lyrae variables in the extremely metal poor globular cluster M92 and eight in the cluster M5, of intermediate metallicity, for use in a Baade-Wesselink analysis. The periods of these variables have been updated by combining observations at the current epoch with older data from the literature. Infrared photometry at $J$ and at $K$ has also been obtained for two RR Lyrae variables in M92 and four in the cluster M5 using a 58 × 62 pixel InSb array.

The advantages of infrared photometry in carrying out a Baade-Wesselink analysis have been amply discussed by Jameson *et al.* (1987) and by Jones, Carney, and Latham (1988). To summarize briefly, in addition to reducing the impact of any interstellar reddening, the use of $K$, a color far out on the Rayleigh-Jeans tail, reduces the sensitivity of the emitted flux to gravity, to metallicity, and to the influence of shock waves. In addition, the $(V\text{-}K)$ color offers a very broad wavelength baseline so that $T_{eff}$ can be determined very reliably.

New radial velocities were measured for the two M92 RR Lyrae variables in a manner similar to Cohen and Gordon (1986), whose data were used for the four M5 variables.

The derivation of the angular diameter – phase relationship from the photometric data has evolved from the scheme of Cohen and Gordon. Basically the Kurucz (1979) model atmospheres are used to define the expected stellar fluxes as a function of $T_{eff}$, surface gravity, and metallicity. The absolute calibration of the observed magnitude systems are given by Oke and Schild (1970) and by Oke and Gunn (1983) for $i$, assuming an effective wavelength of 8100 Å for the $i$ filter. The absolute calibration for $J$ and $K$ is that used by the Caltech infrared group as given in Neugebauer *et al.* (1987). The conversion between observed colors and colors predicted from the Kurucz model atmosphere grid is given by the model atmospheres analysis of Bell and Oke (1986) of the bright metal poor subdwarfs that define the Thuan-Gunn system and also serve as spectrophotometric standards, with infrared photometry from Carney (1983 a,b) to define the zero point of the $(V\text{-}K)$ and $(V\text{-}J)$ colors.

Using the *(V-K)* colors to determine $T_{eff}$ and $K$ magnitudes to derive the total flux, we carry out a Baade-Wesselink analysis with no signs of phase shifts such as those that had plagued Cohen and Gordon (1986). We obtain the distance to M5 of 6.9±0.45 kpc and that to M92 as 7.85±0.45 kpc, with a 0.3 kpc additional systematic uncertainty. The results are in excellent agreement with previously published distances, which are based on fitting the globular cluster main sequence to the subdwarf field stars of known distances.

With these distances we obtain an absolute mean magnitude corrected for reddening, $M_V^0$, of 0.86 ±0.14 mag for the M5 RR Lyraes, while $M_V^0 = 0.62 \pm 0.11$ for the M92 RR Lyrae variables.

The globular cluster RR Lyrae variables behave just like the field RR Lyrae stars. They obey the same $< M_V > -$ [Fe/H] relationship and the same $< M_K >$ – period relationship.

Full details of the photometry can be found in Cohen and Matthews (1992), and of the Baade-Wesselink analysis in Cohen (1992).

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